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ABSTRACT

A study investigated the relationship between existing machine shop engineering programs in technical colleges and the requirements of industry in Zimbabwe. Data were collected from the principals, department headmasters, and a sample of lecturers and students at two colleges, and from personnel managers and workshop managers at nine companies with machine shop production or servicing. Data collection techniques used were interview schedules, questionnaires, inventories, and documents. The following are among the findings reported: (1) there are no exchange programs in which lecturers spend some time in industry and specialists from industry spend time in schools; (2) there is a shortage of important resources such as textbooks and material consumables important to machine shop engineering; (3) the examination board was not sufficiently active at the time of the study to ensure curriculum relevance; (4) the consultation between the curriculum research development unit for technical colleges and industry involves only large companies; (5) on the whole, the level of practical skills acquired by students corresponds fairly well to the requirements of industry; (6) although the colleges prepare journeyworkers with the requisite skills, companies do not seem to involve journeyworkers in decisionmaking, problem solving, and drawing; and (6) the planned work experience enhances the quality of the students' practical proficiency. (The document includes 36 references, the questionnaires, and the interview schedules.) (CML)

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The relevance of machine shop engineering programs in technical colleges to industry in Zimbabwe

Sisco Gweru

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THE RELEVANCE OF MACHINE SHOP ENGINEERING PROGRAMS IN TECHNICAL COLLEGES TO INDUSTRY IN ZIMBABWE

Sisco Gweru

DISSERTATION

submitted as partial fulfilment for an
MA DEGREE IN METALWORK EDUCATION

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THE RELEVANCE OF MACHINE SHOP ENGINEERING PROGRAMS IN TECHNICAL COLLEGES TO INDUSTRY IN ZIMBABWE

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The purpose of this study was to examine the relevance of existing machine shop engineering programs in technical colleges, in preparing students for the world of industry in Zimbabwe. Two colleges and nine companies were selected. The principals, heads of departments, lecturers, personnel and workshop managers, officials at the Curriculum and Research Development Unit and the Further Education Examination Board were all interviewed. Eighty-five students completed questionnaires. Inventories were used to obtain information about plant and equipment. Documents were analysed. The findings showed that: there does exist consultation on curriculum development between technical colleges and industry although not necessarily on a regular basis; there are different ways of contact; generally, the knowledge, skills and attitudes fostered in students correspond fairly well to the requirements of industry; equipment in colleges and industry is basically compatible; there is planned work experience for students; on the whole, employers do not expect journeymen to, for example, make production decisions or to innovate; supplies of consumables and relevant textbooks in colleges are inadequate; lectures' industrial experience and expertise is generally seen by industrialists as inadequate.

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FOREWORD

This Master of Arts dissertation was prepared within the framework of a bilateral cooperation project between Sweden and Zimbabwe. The Swedish International Development Authority - SIDA - provided financial support for the project.

Linköping University has been responsible for the education in cooperation with the University of Gothenburg. Fifteen students participated in the programme. Three students completed the main part of their education at University of Gothenburg. Twelve students completed their education at Linköping University.

For the twelve Linköping University students, the Department of Crafts and Design held the major responsibility for the courses. The exceptions being the course in research methodology and the actual preparation of the dissertations where the Department of Education and Psychology was responsible. Facilities for the fieldwork were provided by the University of Zimbabwe.

The Department of Crafts and Design has been the host department and responsible for the administration and coordination of the programme.

Linköping May 16, 1989

Bengt Wetterstrand
Head of Department
Dept of Crafts and Design

Lars Owe Dahlgren
Professor and Examiner
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The author is also especially grateful to Gordon Evans, for editing the draft of this study.

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BACKGROUND AND PURPOSE OF THE STUDY

The research area of this study concerns the relevance of technical/vocational education programs in preparing students for the world of work. The purpose of the study was to examine the relevance of existing machine shop engineering programs in technical colleges, in preparing students for the world of industry in Zimbabwe.

During the colonial era, Zimbabwe was run on the basis of white workers being skilled and black workers being semi-skilled. Moyo (1988) asserts that:

> *"The colonial form of production organisation was based on very tight control over black unskilled and semi-skilled labour by white managements. White workers, on the other hand, formed a labour áristocracy`, which possessed the skills and jealously guarded their 'skilled' jobs".*

With the advent of independence, some white skills and knowledge left the country. This left a shortage of skilled people to lead the country towards economic development, although there are seven technical colleges in the country. Paradoxically there are some qualified journeymen (skilled craftsmen) in different trades, who are either underemployed or unemployed- for example in boiler making, plate welding, and bricklaying.

In Zimbabwe there is a high degree of dependence on the technology of the outside world. According to the Republic of Zimbabwe's First Five-Year National Development Plan 1986-1990 (1986), the main characteristics of the Zimbabwe economy are heavy reliance on export of raw materials and importation of finished products. The Plan reveals that 84% of the total imports are intermediate and capital goods. The capital goods which account for over 30% of total imports, range from light and heavy-duty machinery and hand tools to precision instruments; while intermediate goods include simple things like screws, bolts and nuts, and simple agricultural implements such as tractor drawn ploughs and harrows. Some of these things could be made in the country: the production involves relatively simple processes. Although there is a big iron and steel manufacturing plant at ZISCO*, Zimbabwe also imports consumables such as quality steel bars and sheet metal.

It is beyond doubt that the type and volume of imported goods clearly demonstrates that manufacturing industry in Zimbabwe does not provide a sound base for self-reliant and self-sustained economic development. This is despite the Government policy that the country should have a technological import-export balance (First Five-Year National Development Plan, 1986).

It is in the light of all this, that the following research question has been asked: 'What is the relationship between existing machine shop engineering

* Zimbabwe Iron and Steel Company

programs in technical colleges and the requirements of industry in Zimbabwe?'

It is hoped that the findings of this study will illuminate the strengths and possible limitations concerning the relationship between existing machine shop engineering in technical colleges and industrial needs. The results of the study should shed light on the problems so that curriculum developers could exploit these results in order to determine whether to improve, revise, modify, supplement or maintain existing machine shop engineering programs in technical colleges.

By way of contribution, the model set by this study will be useful for analyses of other institutional technical education programs. It can serve as a foundation for future research in these areas.

This study is presented in series of chapters. Chapter one contains the theoretical background of the study. It reviews technical education programs in other countries, gives a definition of 'relevance', reflects how relevance can be achieved, and defines the foundation/model of the study and the research objectives.

Chapter two outlines the methods and procedure used to gather the data in the field. It gives arguments in favour of: subjects selected, chosen design and data collection methods, and how the instruments were made up to include all the constructs to be investigated. It contains a description of how the researcher ensured the validity and reliability of the interview schedules and questionnaires.

Chapter three is a comprehensive description of the research findings.

In chapter four the results are discussed. A summary is made and an interpretation of the results is attempted based on the theoretical and empirical material brought out by the investigation. Implications and applicability of the findings are discussed.

1. TECHNICAL EDUCATION AND ITS PREPARATION OF 'MANPOWER'

This chapter forms the theoretical basis of the study. It gives a general review of: technical education programs in other countries; a definition of the term 'relevance'; and it shows how relevance can be achieved in technical education. The chapter also includes the foundation/model of the study as well as stipulating the objectives of the study.

1.1 Technical education in other countries

This section gives a review of technical education programs in different countries paying attention to how these countries prepare students for the world of work.

In Britain, industry takes an active part in technical education. Industry supports, for example, such initiatives as the Technical and Vocational Education Initiative (TVEI) of the Manpower Services Commission and Understanding British Industry. Employers and trade unions are represented on the numerous examination boards that award craft and technical credentials. This gives ready recognition to the credentials awarded.

Developments of technical education programs include:
1) the establishment of industrial groups advising on curriculum development;
2) institutions inviting local employers to see which subjects are taught and how;
3) exchange programs where instructors spend some time in local industry and the industrialists in technical education establishments.

Students are given work experience in industry and it is argued that this experience fosters the skills, knowledge and attitudes that industry requires (see e.g. Poignant, 1973; Wray, 1982; Farley, 1985; Finn, 1985; Jamieson, 1985; Manpower Services Commission, 1985; Noah and Eckstein, 1988).

In France, colleges are twinned with enterprises. There is encouragement of local and regional collaboration between colleges and industry. Emphasis is on:

1) the provision of opportunities for work experience;
2) the joining of industry and colleges for collaborative research and design, and/or training;

3) the involvement of firms in providing institutions with materials and equipment; and
4) facilitating the membership of industrial personnel on the examination boards (Poignant, 1973; Noah and Eckstein, 1988).

The training system in the Federal Republic of Germany is said to be effectively combining school education and vocational training. The so-called 'Dual System', which involves training in institutions and on the job, helps trainees to acquire specific knowledge that ultimately serves to promote industrial efficiency. This dual system principle also exists in other German-speaking countries of Europe - Austria, Switzerland and GDR. Employers are involved in the development of technical education curricula and the board of examiners is made up of representatives from industries and institutions (Poignant, 1973; Deutscher Industrie-und Handelstag 1987; Bowman, 1988; Noah and Eckstein, 1988).

In Sweden, technical students do a training attachment to industry of one year between the first and second year of their studies. In order to foster suitability and readiness in students for the world of industry, labour dynamics are included in the curriculum. Students are introduced to:
a) social economic affairs,
b) trade unions and other labour market organisations
c) industrial safety,
e) industrial democracy,
d) personnel welfare and
f) matters concerning joint determination and cooperation (Poignant, 1973; Marklund, 1988).

In the Soviet Union, the 1984 changes in structure and content of vocational training encourages practical training based in institutions, but the institutional programs should be complemented by on-the-job training in industry. In cooperation with industry, state committees draw up suitable curricula and syllabi. The content of vocational training emphasises that labour training is not mere instruction in practical skills, but that desired attitudes towards both work and society should also be inculcated in the students (O' Dell, 1988).

In the United States of America post-secondary technical education is mainly technician training. Cooperative programs do exist, where training alternates between institutions, and work in an enterprise. However, the training of skilled workers still seems to be largely provided by industry itself. Local industry-education councils have been established across the nation to bridge the gap between industry and vocational education. These councils link policy makers from both education and industry, in order to create a situation that will prepare young people to be productive working members of society (Poignant, 1973; Banchik et al, 1979; Walker, 1985).

In Japan, Junior Vocational Training Colleges (Shoukgyo Kunren Tanki Daigaku) were established in 1973 in order to meet manpower demands resulting from the rapid progress of science and technology. The colleges aim at providing basic training for upper secondary school leavers and producing technicians who have both skills and knowledge in science and technology. The colleges have an important role in the history of Japanese vocational education and training, because they are the first institutions in the country to try to combine practical skills and scientific knowledge at the higher education level.

As a result of the bias toward general education in Japan, about 70% of the upper secondary school leavers and 60% of university graduates are not trained for a specific job when they start working. The companies train them. It is argued that students with a strong background in general education have an advantage, because, in a time of rapid technological progress, a deep and wide range of general knowledge is more useful than specific vocational skills- which may anyway soon be obsolete. Since Japanese companies adopt a so-called lifetime employment system, what they are most concerned about in employing new graduates is their potential. Japanese companies look at employees' potential and then train them as flexible manpower. In other words, companies keep training their workers as job needs dictate. They can mobilise them at any time and in any direction. All employees are expected to have the potential to do any type of job. It is asserted that this flexibility of manpower gives Japanese industry a strong advantage (Inoue, 1985).

1.2 Relevance - what is it?

The models discussed in the previous section on the whole reflect a universal struggle for relevance in technical education. Relevance seems to be a key question in educational dynamics. How do different educationalists perceive this phenomenon of relevance?

In his definition, Bruner (1972) refers to the relation of education to man and society. Bruner`s perspective of relevance has two senses. The first is that what is taught should have a bearing on the grievous problems facing the world, the solutions of which may affect our survival as a species. This is social relevance. Then there is personal relevance: what is taught should be self-rewarding by some existential criterion of being real or meaningful to the student.

What other educationalists state about relevance, can always be identified or interpreted in terms of Bruner's two types of relevance. Doherty (1985) for example, asserts that relevance in education means that:

1) young people are given the basic tools they need to participate as developed citizens of society, and that,

2) they are prepared for specialised work.

As an additional perspective Doherty goes on to contend that relevant education is a phenomenon which keeps abreast of changes in economic life practices and which provides a labour force ready for the demands of new technologies. In a similar vein, Yoloye (1986) conceptualises relevance as a phenomenon which takes account of the African child's development, the African environment, the African cultural heritage, and the demands of technological progress and economic development. It could be argued that the two authors' perspectives of relevance place great emphasis on change and the future. A relevant educational system is seen as one which fosters qualities of flexibility and adaptability that will prepare students for the inevitable technological changes in the world of work.

The Manpower Services Commission (1985), although discussing particularly what is a relevant curriculum, also emphasises the aspects of change and the future portrayed by Doherty and Yoloye. The Manpower Services Commission sees a relevant curriculum as one which prepares young people for the world of work, to meet the demands of a rapidly changing society, and to contribute more to the life of the community. This perspective is enhanced by Knamiller (1984) who portrays the 'issue-based' curricula in some developing countries as relevant, in that it purports to put the child and his community 'en rapport'.

What these educationalists are asserting, is that relevance could be seen as an appropriate relationship between what is learnt, how it is learned, and the individual's personal, social, economic and cultural roles and needs. Relevance involves keeping pace with the inevitable technological developments and demands.

In the context of this study, relevance will be seen as the degree of effectiveness and efficiency of technical education programs in preparing students for industry. The particular definition of 'relevance' for this study will be 'the compatibility of existing technical education programs in technical colleges with the requirements of industry'.

1.3 How can relevance be achieved?

Assertions in the previous section about the meaning of relevance, provoke the question of what institutions should do to provide relevant technical education.

For the content of technical education to be relevant, the curricula, textbooks and methods of instruction must take account of student's development and the demands of technological progress and economic development. It is then,

not only a question of preparing the student for the present, but also a question of preparing him for the future. Relevance in the curricula, textbooks and methods of instruction, must therefore involve a 'now' component as well as a 'forward plan' component. While still considering technological changes that take place in industry, the curriculum and methods of instruction should foster a problem solving mentality, by giving students direct responsibility and expecting an active participation in one's task. Obedience is not enough. To prepare students for the inevitable changes in industry, qualities of flexibility and adaptability should be fostered (Visalberghi, 1973; Fägerlind and Saha, 1983; Doherty, 1985; Yoloye, 1986; Oxenham, 1988).

Furthermore, students should be helped to acquire habits, insights and ideals that will enable them to meet the duties and responsibilities of industry (see e.g. Tanner, 1975; OECD, 1980; Fägerlind and Saha, 1983; Timar, 1983). The instruction should develop suitable manipulative skills, productive skills, psycho-motor and aesthetic abilities, communication and computation skills, and those understandings, attitudes and values that make the worker an intelligent and productive participant in industry. It is contended that the learning of attitudes and behaviour such as punctuality, competitiveness, appreciation of efficiency in production, commitment, cooperation and organisation are necessary dimensions of normative systems if the student is to succeed in the world of work.

Plant and equipment used in educational institutions and in industry must be compatible. It is contended that this compatibility ensures easy transfer of skills learnt in institutions to related occupations in industry. The skills become even more relevant to the requirements of industry if the students go through a dual system of training where they are exposed to both institutional and on-the-job training. It is argued that students thus become familiar with new processes, machines, equipment and techniques of market approach, much sooner at their place of work than they would in institutions. They become accustomed to using their skills and knowledge to solve real-world problems. The students' appreciation of the importance of efficiency in production, and more positive attitudes towards industry are reinforced. The dual system provides a close link between institutions and industry (Manpower Services Commission, 1985; Deutscher Industrie-und Handelstag, 1987).

Students are better equipped to enter the world of employment if there are close links between educational institutions and industry. (see e.g. Visalberghi, 1973; Tanner, 1975; Banchik et al, 1979; Manpower Services Commission, 1985; Deutscher Industrie-und Handelstag, 1987; Castro, 1988; Noah and Eckstein, 1988).

Another link is regular and timely consultation between institution and industry in areas like curriculum development. This link is important because

it ensures that college curricula keep pace with technological developments in industry.

A third link is open and regular communication between college lecturers and industrialists. It is argued that an on-going informational flow between colleges and industry helps to provide a good match between institutional training programs and the demands of related occupations in industry. By keeping a close contact, the college and employers develop a detailed understanding of mutual needs. Furthermore, it is contended that regular communication between college lecturers and industrialists is a major component for efficient technical education providing students with up-to-date information about developments in industry. It is suggested that one approach to these issues is through the establishment of advisory councils for occupational education.

A fourth link is where industry and college are represented on the examinations boards. In view of the decisive influence of examination boards over curricula, this link is undoubtedly vital.

Lastly, there is the occasional secondment of college lecturers to industry to ensure that their technical knowledge and skills are always up-to-date, and the invitation for specialists from industry to work in colleges for a similar period on exchange.

1.4 Foundation/model of the study and research objectives

Arguments spelt out in the previous sections suggest that relevance can be seen through the compatibility between the requirements of industry and what the college can provide. In the light of this assertion the following line of thought/model will be used as the point of departure for this study (see Figure 1).

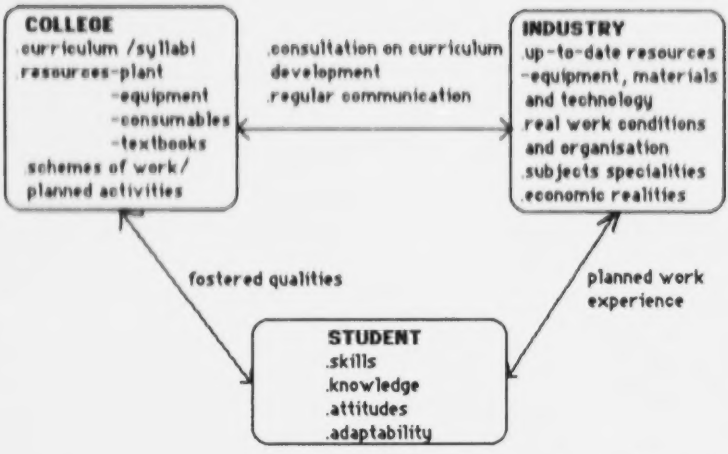

Figure 1. Foundation/model of the study: Interactional training model for manpower

The foundation/model of the study shows the two main elements involved in preparing suitable manpower for industry. The two elements for turning the student into "a manpower", are the college and the industry. The nature of interaction between these elements determines the manpower quality.

More explicitly the model explains that:

- regular consultation on curriculum development, and regular communication between industry specialists and college lecturers ensurethat college programs are up-to-date and compatible with industry requirements,
- college programs comprising curriculum/syllabi, resources and schemes of work, foster in students skills, knowledge, attitudes, and adaptability, in order to prepare them for work in industry,
- industry enhances the qualities of students' skills, knowledge, attitudes and adaptability, by providing students with planned work experience (on-the-job training) where there should be provision of up-to-date resources, real work conditions and organisation, as well as subject specialities.

In view of these arguments, the main objective of this study is to examine the relevance of machine shop engineering programs in technical colleges, in preparing students for the world of industry in Zimbabwe.

The specific objectives of this study are:

1. To examine the nature of communication, and consultation on curriculum development, between technical colleges and industry.
2. To determine if machine shop engineering curriculum/syllabi, schemes of work, textbooks and consumables used in technical colleges, correspond to the requirements of employers in industry in terms of knowledge, skills, attitudes and adaptability.

3. To determine if the plant and equipment used in technical colleges are compatible with industry requirements/set ups.

2. METHODOLOGY

Technical colleges in Zimbabwe offer a wide range of trades but this study has focused on one, 'machine shop engineering'. This means that this study is an intensive investigation of a case. It appears that the research question has not been studied previously, and the objectives are such that the researcher has had to use an intensive investigation. Hence the selection of one trade and the use of the case study approach. This approach often produces a wealth of new insights, whereas a host of surveys, for example, may yield few new ideas (Selltiz et al, 1959)

2.1 Subjects

Two colleges were selected, one a pre-independence establishment, and the other a post-independence establishment. The principals, heads of departments, and a sample of lecturers and students were selected. These subjects were chosen to ensure adequate representation of different types of experience within the institutions. Selltiz et al (1959) assert that selection of individuals who represent different positions helps to produce a rounded view. The choice of subjects was extended to two bodies that are instrumental to the development of machine shop engineering programs in technical colleges - the Curriculum and Research Development Unit (CRDU), and the Further Education Examination Board (FEEB). One official from each of these bodies was selected. The rationale for this extension was to obtain an even more comprehensive perspective of information.

Since the purpose of the study was to examine the relevance of machine shop engineering programs in technical colleges to the world of industry, nine companies with machine shop production or servicing were included. These companies were possible employers. Three were big companies, three medium and three small. Two of them were located in Bulawayo, one in Midlands and six in Harare. This assortment would enable the researcher to explore different possibilities concerning compatibility of machine shop engineering programs in technical colleges with various levels of engineering industry. Personnel managers and workshop managers selected as subjects would have a reservoir of knowledge and experience concerning the employees who had studied machine shop engineering in technical colleges.

2.2 Instruments

Interview schedules, questionnaires, inventories and documents were used as the main modes of collecting data. All these were necessary because of the information needed about objectives. Such a diversity of instruments is not unusual in the social sciences. (see e.g. Teryek, 1979; Burgess, 1985).

Since interviews have the advantage of adaptability and since their interpersonal nature allows more open-ended questions and interviewer probing (Wiles, 1972; Mason and Bramble, 1978; Teryek, 1979; Bell, 1987), this technique was chosen. Interviews were used for collecting information about the nature of communication, and consultation on curriculum development, between technical colleges and industry. They were used to obtain information about machine shop engineering curriculum/syllabi, schemes of work, textbooks and consumables used in technical colleges in terms of knowledge, skills, attitudes and adaptability. Interviews were also used to obtain information about plant and equipment in technical colleges and in industry. The interviews were meant for principals, heads of departments and lecturers, one official at CRDU, one official at FEEB, personnel managers and workshop managers in industry.

For straightforward and factual enquiries, and as long as subjects are sufficiently literate, (see e.g. Travers, 1966; Teryek, 1979; Bell, 1987) a questionnaire is a good way of collecting information quickly and relatively cheaply. Because of this advantage, questionnaires were chosen to collect students' experiences concerning machine shop engineering programs in the two technical colleges.

Document analysis was selected to complement and cross-check information obtained through interviews and questionnaires. It is asserted that in social sciences, document analysis can serve a useful purpose in yielding information that is helpful in evaluating or explaining educational practices (see e.g. Best, 1981; Bell, 1987).

Inventories were chosen to complement and cross-check information obtained through interviews, concerning plant and equipment used in technical colleges and industry.

In order to examine the nature of communication, and consultation on curriculum development, between technical colleges and industry, the interview schedules (see Appendices 1-5) were designed to seek the following information:

Communication:
a) whether there is contact between technical colleges and industry, b) ways of contact, c) frequency of contact and d) personnel involved in the contact.

Consultation on curriculum development:
a) whether there is consultation on curriculum development, b) ways of consultation, c) frequency of consultation d) personnel involved in the consultation, e) matters discussed, and f) occasions when technical colleges require expertise from industry.

To determine if machine shop engineering curriculum/syllabi, schemes of work, textbooks and consumables used in technical colleges correspond to the requirements of employers in industry in terms of knowledge, skills, attitudes and adaptability, questions concerning the following facets were asked in the instruments (see Appendices 1-8):

Curriculum/syllabi:
a) adequacy of training period, b) lecturer/student ratio, c) lecturer qualifications, d) adequacy of equipment, e) adequacy of consumables, f) availability of relevant textbooks, g) provision of on-the-job training, and h) existence of exchange programs for lecturers and industry specialists.

Knowledge:
a) perception concerning journeymen`s knowledge about: materials science/ engineering science, trade unions/labour organisations, industrial safety, workshop management and organisation, and up-to-date resources in industry; b) relevance of mathematical knowledge taught in technical colleges, and c) perception about journeymen's ability to interpret assembly drawings.

Skills:
a) practical proficiency, and b) skills in drawing and design.

Attitudes:
a) punctuality, b) competitiveness, c) pride in workmanship/appreciation of efficiency in production, d) respect for manual work, e) cooperation and f) reliability.

Adaptability:
Preparation of trainees for technological changes in industry.

Other abilities:
a) solving problems, b) decision making, c) concentrating at work, d) exercising initiative, and e) innovativeness.

To determine if the plant and equipment used in technical colleges are compatible with industry requirements/set ups, questions about the following were asked in interviews as well as tallied through inventories (see Appendix 9).

Heavy machinery:- type of machine and condition,
Precision instruments:- type of instrument and condition,
Plant:- size and configuration.

2.3 Validity, reliability and trial run

During the process of designing instruments the researcher regularly consulted and was guided by the supervisor. A researcher has an obligation to ensure the validity and reliability of his interview schedules and questionnaires. Mason and Bramble (1978) contend that the determination of content validity usually depends more on expert judgement than on mathematical procedures. For this reason the researcher consulted a fellow student, a specialist in machine shop engineering, to validate the content of the instruments.

Prior to consulting the expert in machine shop engineering, the researcher had made a logical analysis. He identified variables from his objectives and then operationalised these variables in order to formulate questions. The aim was to ascertain that all the necessary constructs that were to be investigated were actually included. This line of argument is supported by Helmstadter (1964) who contends that although content validity depends upon the judgement of an expert in the field, it involves far more than mere looking at items to see if they appear to do the job. Helmstadter argues that content validity requires a careful definition in behavioural terms of the content to be measured, and a breakdown of the total into categories which represent all aspects.

According to Selltiz et al (1959), and Bell (1987), instruments must be pretested to ensure that they will collect the information needed, before they are used in the proper study. They argue that questions that seem clear and straightforward to the researcher, may, in a trial run, prove difficult to comprehend or ambiguous. Nisbet and Entwistle (1970), also point out the necessity of a pilot study, to ensure that question wording means the same to every respondent. For these reasons the researcher took the precaution of avoiding factors that could affect reliability of his interview schedules and questionnaires by: a) frequently consulting a fellow student about the quality of question wording and b) instituting trial runs with a sample of ten machine shop engineering students and a company personnel manager. The instruments seemed to work effectively and hence no amendments were made to the original question wording. The ten students answered the questionnaires correctly and the personnel manager responded to the interview without difficulties.

2.4 Procedure

Prior to field work, the University of Zimbabwe, Department of Curriculum Studies had ensured the institutions' and the companies' participation. This made it possible to complete the field work within the time available. The researcher simply telephoned to agree arrangements for the visits.

At the two colleges the researcher interviewed the principals, heads of departments and lecturers. The interviews took about twenty minutes with the principals and an average of thirty minutes with heads of departments and lecturers.

The researcher personally distributed and collected the questionnaires to students during lecture sessions. In one college 38 students (26 first year and second year students, 12 third year and fourth year students) were present and answered the questionnaire and in another college 47 (35 first year and second year students, 12 third year and fourth year students). This was about a quarter of all the machine shop engineering students in both the colleges. Examinations were in progress, so this was the number possible to obtain.

Syllabi, schemes of work, a sample of practical mark lists, departmental resource files, and minutes of industry-college meeting in one of the colleges, were obtained for subsequent analysis.

At the post-independence college, the researcher found a meeting of college lecturers and representatives from two local industries actually in progress. The researcher was allowed to observe the meeting, take notes and ask questions. The researcher also obtained minutes of the previous meeting. The minutes were important because they were an addition to the documents that the researcher had expected to find in the colleges.

Personal interviews were also used to obtain information from CRDU and FEEB. The interviews took an average of twenty minutes.

The researcher's intention in every company, was to interview personnel managers and workshop managers. But in some companies the assistant mechanical engineer, or the training officer, or the general manager were interviewed instead because the personnel manager was unavailable. These interviewees were equally knowledgeable about machine shop engineering programs in their companies and in technical colleges. In one company only the workshop manager was available. The interviews took an average of twenty minutes with personnel managers and an average of thirty minutes with workshop managers.

When visiting the colleges and the companies, the researcher completed inventories of the equipment. This was done immediately after the interview sessions, in each of the nine companies and in both the technical colleges.

All in all, the researcher was well received in both the colleges, in all the nine companies, at CRDU and at FEEB. He was able to obtain information without any problems. The only disturbing factor was that examinations were in progress which affected the number of students available to complete the questionnaires, but not to the extent that this would have affected the quality of the results.

3. RESULTS

The results will be presented in four sections. The first section gives results about the nature of communication between technical colleges and industry. The second section is about the nature of consultation on curriculum development between technical colleges and industry. The third section reports findings about the relationship between knowledge, skills, attitudes and adaptability provided by technical colleges on the one hand, and the requirements of industry on the other. The fourth section reflects findings concerning the compatibility between plant and equipment used in technical colleges and industry requirements/set ups.

In the analysis of data, each college and each company was treated as a unit. For these types of objectives concerned with the relationship between colleges and industry, the individuals are not as important as the college or the company. The individuals were only used to obtain information about each college or each company. Therefore the results of the analysis will be presented by referring to the units - 'college' or 'company', with the only differentiation that of size- big, medium or small- and whether the college is a pre-independence establishment or post-independence establishment.

The information obtained from the colleges refers to industry/companies in general and not necessarily to those investigated in this study. In the same way the information obtained from the nine companies concerns technical colleges in general and not necessarily those investigated.

3.1 The nature of communication

In order to examine the nature of communication between technical colleges and industry, the information obtained through interviews was analysed. The first thing to establish was whether there is any contact at all. It was found that both the technical colleges and 8 out of the 9 companies asserted that there is some form of contact between industry and technical colleges. Only 1 small company said, *"We do not go to them and they do not come to us. If you do not have students in the company for on-the-job training, you do not see anyone from colleges"*.

The information was analysed to find firstly, ways of contact, and secondly frequency of contact. The analysis consisted of finding common aspects/ dimensions which could be used to describe ways of contact and frequency of contact. Frequencies of responses were also established.

3.1.1 Ways of contact

The ways of contacts were classified as: a) reciprocal contact, comprising advisory council meetings, dual system of training students and telephone contact; b) one way contact: informational flow from college to industry, comprising reports on students` progress, examination results, letters, and industry attending open days and graduation ceremonies; and c) one way contact: informational flow from industry to college, comprising reports on students` progress, educational visits to industry, company offering industrial experience and expertise to college, donation of consumables to college, selling equipment to college and questionnaires to employers.

a) Reciprocal contact.
In both the technical colleges interviewees pointed out that liaison meetings are held between college lecturers (advisory council) and representatives from industry. At the post-independence college the researcher participated in a meeting comprising head of department and lecturer in machine shop engineering, and two representatives from industry. The agenda of the meeting focused on ways of improving the quality of training. Minutes of the previous meeting between this college and industry were obtained by the researcher.

Of the 9 companies, only 2 big companies' responses indicated that the companies communicate with technical colleges through advisory council/ liaison committee meetings.

Information obtained from both the colleges and 8 companies, indicated that the dual system of training, whereby students are exposed to both college training and on-the-job training, provides a link between technical colleges and industry. Only 1 small company did not mention this link. The 8 companies pointed out that officials from the Apprenticeship Authority Board, which is also instrumental to the development of training programs in colleges, visit the companies to monitor the progress of students doing on-the-job training. Both the colleges reported that lecturers were supposed to visit students doing on-the-job training, but that shortage of staff and lack of transport have been limiting factors.

Interviewees in both the colleges, mentioned that telephone contacts between the colleges and companies were about 'on-the-job training', and that various aspects of machine shop engineering were discussed.

b) One way contact: informational flow from college to industry.
Both the colleges mentioned informational flow from colleges to industry. This was primarily: a) sending written reports on students' progress in college, and students' examinations results to companies, and b) writing

letters to companies through the Apprenticeship Authority Board, concerning enrolment of new students.

Five companies, that is the 3 big ones and 2 of the medium ones, indicated the existence of the above types of informational flow from technical colleges to the companies.

Both the colleges said that companies are invited to open days and graduation ceremonies. The open days were considered by both the colleges as very important: a) they give industrialists opportunities to see and evaluate what students do in colleges, and b) they provide a forum for industrialists, lecturers and students to discuss issues concerning machine shop engineering. However, only 2 big companies and 1 small one out of the 9 referred to this type of contact.

c) One way contact: informational flow from industry to college.
Interviewees from both the colleges pointed out that companies send colleges progress reports for students doing on-the-job training. Two big companies, 1 medium company and 1 small company mentioned this too.

It was asserted in both the colleges that educational visits for students and lecturers are organised so that they can acquaint themselves with developments in industry. Only 1 big company referred to educational visits as a way of contact with technical colleges.

The post-independence college from time to time invites specialists from industry to give lectures to students on specific topics. This college also maintained that it has always invited specialists to work as part-time lecturers, but so far industry has not found it possible to release these specialists.

Only 1 big company referred to one of its specialists in machine shop engineering, doing part-time lecturing at a local technical college.

In the post-independence college lecturers with no industrial experience, are given opportunities to work in a local company during college holidays.

The post-independence college pointed out that some local companies donate consumables to the college. Two of the medium companies mentioned this too.

Whereas 1 small company mentioned that it sells equipment to technical colleges, as a way of contact, this was not taken up by the colleges.

The pre-independence college sent questionnaires to employers in industry to find out their thoughts about machine shop engineering programs in the college.

3.1.2 Frequency of contact

Frequency of contact between technical colleges and industry, was classified as: a) regular contact and b) irregular contact.

a) Regular contact:
Information obtained showed that 2 big companies, 2 medium companies and 2 small companies have regular contacts with technical colleges, and that both the colleges have regular contacts with industry. Three of these companies, that is 1 big, 1 medium and 1 small have contacts with technical colleges once every month. One medium company is in touch with the Apprenticeship Authority Board every two weeks. According to 1 big company, their contact is an on-going process. Information obtained from the pre-independence college showed that: a) every six weeks, students progress reports are sent to companies that provide on-the-job training b) industries are invited to open day and graduation ceremony each year and c) students doing on-the-job training are visited once a month. In the post-independence college advisory council meetings are held at least once a month as needed.

b) Irregular contact:
In both the colleges it was mentioned that telephoning occurs any time an important issue crops up.

One big company and 1 medium company pointed out that although contact between the companies and technical colleges exists, it is rather sporadic. The big company holds meetings with representatives from a local technical college three or four times a year, but irregularly.

3.2 The nature of consultation on curriculum development

In order to examine the nature of consultation on curriculum development between technical colleges and industry, the information obtained through interviews was analysed. The first task was to establish whether there is consultation. There is. Officials at CRDU and FEEB, and 3 big companies and 1 medium company out of the 9 stated that there is consultation on curriculum development. The other 2 medium companies and all 3 small companies, asserted that they are not consulted. However, they wished to be consulted on curriculum development.

The information was analysed in terms of: a) ways of consultation, b) frequency of consultation, c) personnel involved in consultation and d) timeliness of consultation. Frequencies were also established.

3.2.1 Ways of consultation

Two principal modes of consultation on curriculum development were identified: a) direct consultation/involvement and b) indirect consultation/ involvement.

a) Direct consultation/involvement:
One big company argued that a local technical college consults companies through liaison committees in order to keep up-to-date with developments in industry. The company also asserted that its training school liaises very closely with the college on curriculum issues. The other big company pointed out that its representatives are invited by a local technical college to discuss curricula issues in liaison committees.

b) Indirect consultation/involvement:
An official at CRDU mentioned that industry is consulted on curriculum development through National Manpower Advisory Council (NAMACO). Reference was also made to the symposium on Technical/Vocational Education held at Nyanga Zimbabwe from 11-15 September 1988, where participants included representatives from industry. An official at FEEB disclosed that principals of technical colleges, lecturers, CRDU and employers' associations meet to discuss policy issues and to approve matters concerning curricula. However, at the time of this study, it was pointed out that FEEB had not been active for quite some time. No meetings had been held since the interviewee joined the Board, four months before the day of the interview.

Of the 4 companies consulted on curriculum development, 1 big company and 1 medium company contended that their involvement in curricula issues is indirect, through employers' associations.

3.2.2 Frequency of consultation

By going through the information, frequency was classified as: a) regular consultation and b) irregular consultation.

a) Regular consultation:
An official at CRDU said that consultation with industry takes place whenever it is necessary, through the National Manpower Advisory Council. Major consultations on curriculum development take place once per year. One big company viewed its involvement in curriculum issues as regular, although only once per year. Information obtained from this company showed that it also holds monthly meetings with a local college.

b) Irregular consultation:
Information obtained from FEEB indicated that meetings with employers' associations are supposed to take place once a month. Unfortunately, at the time of the interview, there was no consultation between employers' associations and FEEB. One big company also perceived its involvement in curricula issues as irregular, although meetings are held with a local technical college three or four times per year.

3.2.3 Personnel involved in the consultation

When it concerns major consultations on curriculum issues, information obtained showed that from the Ministry of Higher Education, the following are involved: Chief Education Officer Technical (chairperson for FEEB), Secretary for FEEB, representatives from Apprenticeship Authority Board, Principal Manpower Development Officer (head of CRDU), principals of colleges and heads of departments. The 4 companies consulted on curricula issues, either directly or indirectly, mentioned that Employers' Associations, Zimbabwe Institute of Engineers, staff development officers, and training officers represent industry.

3.2.4 Timeliness of consultation

Two big companies asserted that their expertise is sought by technical colleges throughout crucial stages of curriculum development and whenever there are curricula changes to be made. However, the other 7 companies expressed feelings that their expertise is never sought when it concerns curriculum development.

3.3 The relationship between what colleges teach and the requirements of industry.

To determine if machine shop engineering curriculum/syllabi, schemes of work, textbooks and consumables used in technical colleges correspond to the requirements of employers in industry in terms of knowledge, skills, attitudes and adaptability, information obtained through interviews and documents was analysed. This involved the grouping of information into verbal categories. Frequencies of responses were also established. Information obtained through questionnaires was analysed too. The information was put into verbal categories and a computer program Stat View 512+tm was used in order to get frequencies or percentages, based on nominal and ordinal scales.

3.3.1 Curriculum/Syllabi

a) Adequacy of training period:
Interviewees at the pre-independence college, expressed the view that the duration of the course is adequate. On the whole, this view was not shared by students. As illustrated by figure 2, out of the 38 students who answered the questionnaires, the majority (65.8%) indicated that the training period is insufficient.

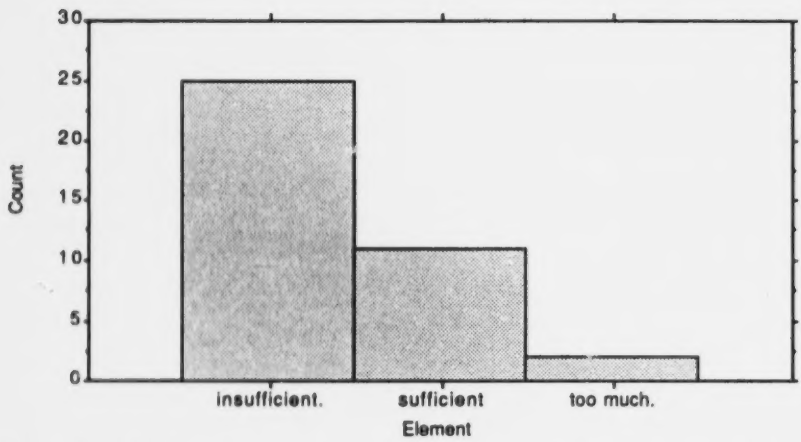

Figure 2. Students' perceptions about adequacy of training period in the pre-independence college.

In the post-independence college, interviewees asserted that the training period is inadequate. The reason given was that the training duration is not commensurate with the demands of the syllabi. Out of the 47 students in this college, who answered the questionnaires, the general feeling about this issue seemed to be on the balance except for only 2 students who indicated that the training period is too much. Figure 3 illustrates this.

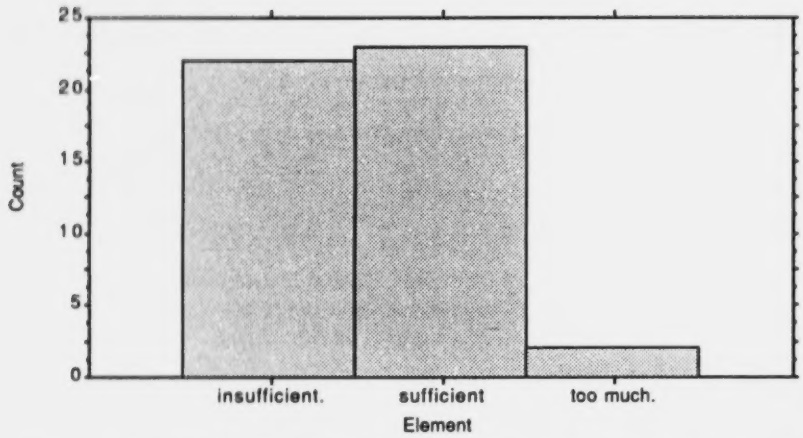

Figure 3. Students' perceptions about adequacy of training period in the post-independence college.

Only 1 small company viewed the training period in machine shop engineering as inadequate to enable trainees to acquire the knowledge, skills and attitudes required by industry. This company contended that trainees are only given basic practical training and that some of the qualified journeymen can not even read a micrometer accurately. The general feeling from the other 8 companies was that training duration is sufficient but that this does not guarantee quality training.

b) Lecturer/student ratio:
Interviewees in both the colleges perceived lecturer/student ratio as adequate. The students at the pre-independence college tended to perceive the ratio as adequate (see Figure 4).

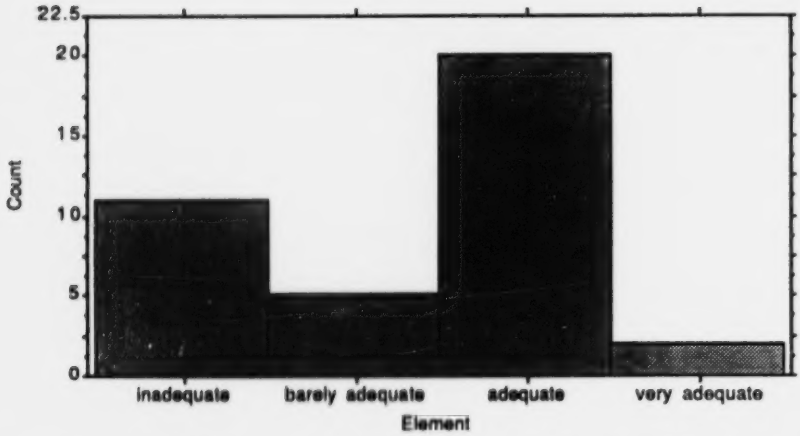

Figure 4. Students' perceptions about adequacy of lecturer/student ratio in the pre-independence college.

Students in the post-independence college tended to perceive the ratio as inadequate (see Figure 5).

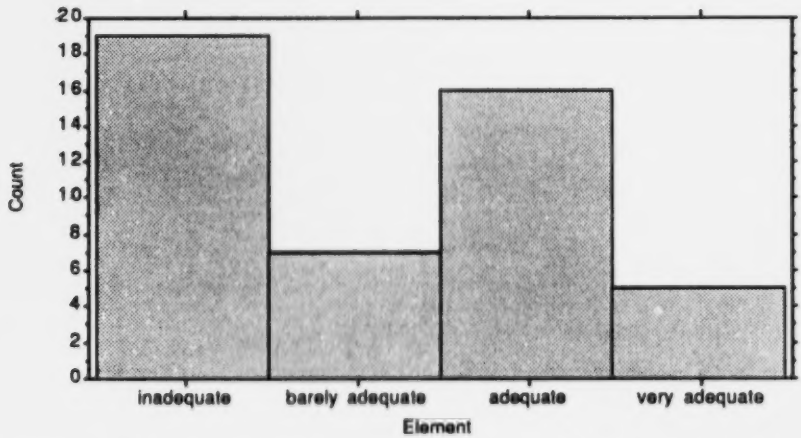

Figure 5. Students' perceptions about adequacy of lecturer/student ratio in the post-independence college

Seven companies thought the ratio inadequate. One small company thought that there were enough lecturers in technical colleges, the other small company assumed that technical colleges were fairly staffed.

c) Lecturer qualification:
It was pointed out in the pre-independence college that all lecturers in machine shop engineering are qualified journeymen, with a minimum of three years industrial experience. In the post-independence college it was asserted that most lecturers are qualified journeymen with a minimum of three years industrial experience. The majority of lecturers in both the colleges lack formal teacher training qualifications.

On the same issue it was found that 2 big companies believed that lecturers in technical colleges are fairly well qualified. One of these companies argued that lecturers in colleges should have at least a diploma or degree. The other one asserted that some lecturers in colleges have no industrial experience. Six companies believed that lecturers in colleges are qualified but they lack enough industrial experience and expertise. One medium company believed that lecturer qualifications are adequate. It was however, generally believed in industry that competent and experienced experts in machine shop engineering left colleges and either joined industry where there is better remuneration or left the country at independence.

d) Exchange programs for lecturers and industry specialists:
Information obtained from both the colleges and all the 9 companies indicated that there are no definite official exchange programs where lecturers from colleges work in industry for a certain period in order to familiarise themselves with the latest developments in industry and specialists from industry are invited to work in colleges for a similar period. The post-independence college asserted that it invites specialists from industry to act as part-time lecturers, but so far there has been no response. However, at the unofficial level (not ministry policy) 1 big company mentioned that lecturers with no industrial experience from two local colleges, work in the company during college holidays.

e) Adequacy of equipment:
In the pre-independence college, interviewees saw the quantity of equipment as inadequate to match the student population. This perception seemed to be shared by majority of the students. Out of the 38 students, 21 (55.3%) indicated that equipment is inadequate and 8 (21.1%) indicated that it is barely adequate (see figure 6).

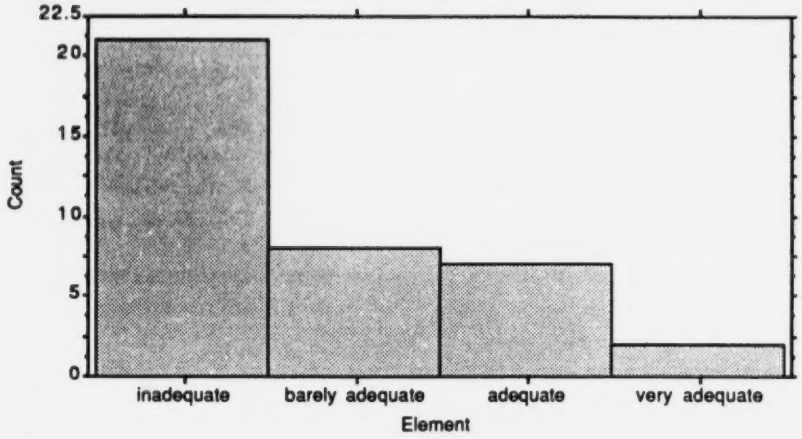

Figure 6. Students' perceptions about adequacy of equipment in the pre-independence college.

In the post-independence college the general feeling of the interviewees was that the quantity of equipment is adequate to effectively cater for the student population. Most of the students perceived the quantity as barely adequate or inadequate. The general pattern of the students' perception about adequacy of equipment is shown in Figure 7.

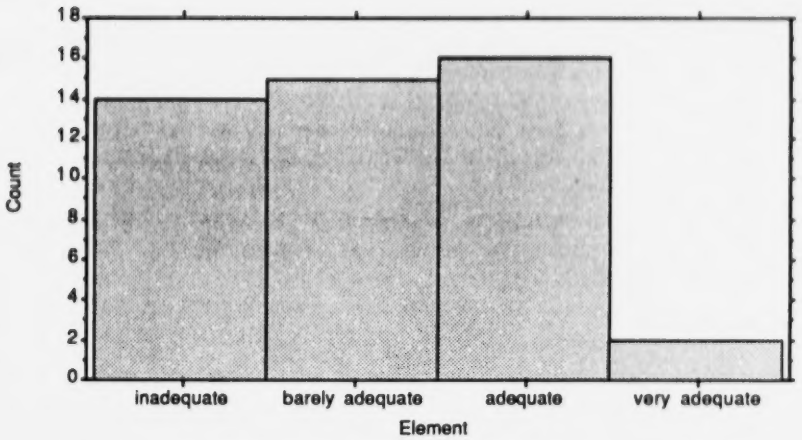

Figure 7. Students' perceptions about adequacy of equipment in the post-independence college.

Four companies perceived quantity of equipment in technical colleges as adequate to effectively cater for the number of students. These comprised 1 big company and all the 3 medium companies. Five companies, that is all the 3 small companies and 2 big companies, perceived quantity of equipment in colleges as inadequate to match the size of classes.

f) Adequacy of consumables:
The findings from both the colleges reflected inadequacy of consumables in machine shop engineering.

Whereas 8 companies perceived that consumables in technical colleges are inadequate, 1 medium company saw them as being fairly adequate.

g) Provision of on-the-job training for students:
Findings from both the colleges showed that students have an on-the-job training component in their training program. During the period of about four years, the trainees spent a total of 18 effective weeks in college per year, and the rest of the time in industry doing on-the-job training.

Eight companies pointed out that they provide on-the-job training for trainees in machine shop engineering. The small company which does not provide on-the-job training argued that it is not set up for training.

h) Summary:
The training duration for machine shop engineering in technical colleges is seen by industry as adequate. Whereas colleges see lecturer/student ratio as adequate, industry sees it as inadequate. The depth and breadth of lecturers' industrial experience and expertise in machine shop engineering do not match employers' expectations. There are no official exchange programs where lecturers from colleges work in industry for a certain period to familiarise themselves with latest developments and specialists from industry are seconded to work in colleges for a similar period. There is no coherence in perceived quantities of equipment in technical colleges. The pre-independence college and 5 companies perceived the quantity of equipment in colleges as inade quate, the post-independence college and 4 companies saw it as adequate. Consumables in technical colleges are inadequate to match the requirements of industry. Students have an on-the-job training component in their training program.

3.3.2 Knowledge

a) Perception concerning journeymen's knowledge about trade unions /labour organisations:
In neither college, is knowledge about trade unions/labour organisations included in the syllabus. Eight out of the 9 companies pointed out that their

journeymen do not display knowledge about trade unions/labour organisations. One small company, however, contended that journeymen in the company are more interested in trade unions (workers' committees) than in doing the actual work.

b) Perception concerning journeymen's knowledge about industrial safety:
Documents showed that knowledge about industrial safety is thoroughly covered as part of all the practical activities. On the same issue 8 companies felt that their journeymen in machine shop engineering have enough knowledge about industrial safety even at job entry level. However, 1 medium company felt that journeymen do not know enough about industrial safety when they start work. It was argued that the company had to foster this knowledge.

c) Perception concerning journeymen's knowledge about workshop management and organisation:
In both the colleges, the syllabus and responses from interviewees and the students, showed that knowledge about workshop management and organisation is not formally covered. All the 9 companies asserted that journeymen have no knowledge about workshop management and organisation. They pointed out however, that they do not require their journeymen to display expertise in these matters.

d) Perception concerning journeymen's knowledge about up-to-date resources in industry:
Documents in both the colleges showed that knowledge about up-to-date resources in industry is part of craft theory which is allotted four hours per week. More than half of the 85 students indicated that the programs include up-to-date resources in industry.

Five companies, 3 big, 1 medium and 1 small, argued that journeymen are adequately equipped with knowledge about up-to-date resources in industry e.g. equipment, materials and technology. The reasons given were that technology in Zimbabwe is actually rather static. Three companies, 2 medium and 1 small, stated that journeymen are not adequately equipped with knowledge about up-to-date resources in industry. Here the contention was that the journeymen who work in these companies seem to have been trained only in basic fitting and turning. One small company saw journeymen as being fairly well equipped with knowledge about up-to-date resources in industry.

e) Perception concerning journeymen's knowledge about material science/ engineering science:
The position in both the colleges is that knowledge about material science/ engineering science is sufficiently covered in the syllabus, especially that for the Zimbabwe Advanced National Craft Certificate (ZANCC). Time

allocation was four hours per week. Both the colleges said that there is an acute shortage of relevant textbooks.

Three big, 2 medium and 2 small companies perceived that journeymen in their companies, particularly those who have done advanced courses in machine shop engineering, have enough knowledge about material science/ engineering science. On the other hand, 1 medium and 1 small companies perceived journeymen's knowledge to be inadequate. They maintained that material science/engineering science taught in technical colleges was limited to basics only.

f) Relevance of mathematical knowledge taught in technical colleges:
The syllabus used in both the colleges covers applied mathematics in detail- particularly at the advanced level- and time allocation for the discipline was four hours per week. However, it was asserted that there is an acute shortage of textbooks.

Seven companies saw the mathematics taught in technical colleges as relevant. This was despite the concern shown by these same companies that more emphasis should be laid on applied mechanics. The 7 companies comprised all the 3 big companies, 2 medium companies and 2 small companies. However, 1 medium company saw the mathematical knowledge as fairly relevant. The argument given was that journeymen in the company do not know enough about the imperial system and yet the country still uses machines with imperial facilities. One small company asserted that mathematical knowledge taught in colleges is poor and irrelevant. The contention pronounced was that some qualified journeymen in the company cannot, for example, efficiently use precision instruments, have limited knowledge about new standards of fits and fittings, and cannot convert imperial to metric and vice versa.

g) Perception concerning journeymen's ability to interpret assembly drawings:
Information obtained from both the technical colleges showed that trainees are quite good at interpreting assembly drawings. Interviewees asserted that feed-back from industry concerning this issue is positive. The documentary material available, that is, syllabi and schemes of work, indicated that the area is well covered particularly at the advanced stage of the course. However, the shortage of relevant textbooks was mentioned here too.

Three companies, that is 1 big, 1 medium and 1 small perceived their journeymen as good at interpreting assembly drawings. Four companies, that is, 1 big, 2 medium and 1 small, perceived their journeymen to have satisfactory ability. One big company considered its journeymen to be fairly able at interpreting assembly drawings. One small company asserted that most of its journeymen lack this ability. The argument given by this small company was that the journeymen were not trained to think and solve problems independently.

h) Summary:
Technical colleges do not provide knowledge about trade unions/labour organisations. Knowledge about industrial safety is adequately fostered in students. Only one company asserted that journeymen are not adequately knowledgeable about industrial safety at job entry level. Technical colleges do not provide knowledge about workshop management and organisation and companies do not require journeymen to display expertise in these matters. Five companies perceived journeymen's knowledge about up-to-date resources in industry as adequate, and 1 company perceived it as fairly adequate. Three companies perceived this knowledge as inadequate. There is basically a correspondence between the content of materials science/ engineering science offered in colleges, especially at advanced level of training, and the requirements of industry. However, there is an acute shortage of textbooks. Mathematics taught in colleges largely corresponds to what is required in industry. The only discrepancy is on the degree of emphasis concerning applied mechanics, conversion from metric to imperial and vice versa and efficient use of precision instruments. What is covered in colleges concerning interpretation of assembly drawings, corresponds pretty well to the requirements of industry.

3.3.3 Skills

a) Practical proficiency:
A sample of mark lists obtained from both the technical colleges reflected a spread of a fairly high standard of students' practical proficiency in machine shop engineering. Out of the 85 students, only 20 (23.5%) think that the machine shop engineering taught does not equip them with skilled craftsmanship that will enable them to cope with the demands of industry.

Five companies asserted that the journeymen they employed display the skilled workmanship required. These comprised 2 big, 2 medium and 1 small companies. However, among these 5 companies, 1 medium company said that only the journeymen who did their on-the-job training in that company were good. Journeymen who trained in other places cannot efficiently operate horizontal boring machines, it was argued. The remaining 4 companies were of the opinion that journeymen had not acquired the levels of skills required in industry. The arguments given were that quality of technical proficiency is generally lacking and that the selection criteria for new trainees is not sufficiently rigorous.

b) Drawing and design skills:
It was found that in both the technical colleges, 4 hours per week of drawing and design is included in the syllabus. Out of the 85 students only 11(12.9%) indicated that drawing and design is not included in the programs. 74 (87.1%) indicated that drawing and design is included. But, however, accor-

ding to the researcher's analysis of schemes of work, design seems not to be included.

Seven companies stated that drawing and design skills are not required. The argument given was that for journeymen only reading skills are needed. The remaining 2 companies, that is, 1 medium and 1 small company, asserted that their journeymen are on the whole poor at drawing- let alone design.

c) Summary:
The level of journeymen's practical skills corresponds fairly well to the requirements of industry, with 5 companies seeing this level as adequate and 4 seeing it as inadequate. There is a discrepancy between drawing and design skills provided in colleges and the requirements of industry. Employers expect journeymen to be competent in reading skills only.

3.3.4 Attitudes

a) Punctuality:
Interviewees in both the colleges asserted that punctuality is emphasised. In the pre-independence college 19 (50%) out of the 38 students perceived that punctuality was not very much emphasised. In the post-independence college 43 (91%) out of the 47 students perceived punctuality as being emphasised a lot.

The situation in industry was that 5 companies felt punctuality was not adequately fostered in trainees in technical colleges. The reason given was that some of the journeymen working in these companies are not always punctual. The remaining 4 companies comprising 1 big company and 2 small companies asserted that their journeymen are always punctual.

b) Competitiveness at work:
Analysis of information obtained from both the colleges indicate that competitiveness at work is fostered in trainees by way of formative and summative assessments. In the opinion of 6 companies, journeymen in machine shop engineering are not competitive at all. These companies asserted that most of the journeymen are too slow and lack efficient methods of production. One big company seemed to suggest that competitiveness is not necessary in the company situation. Only 2 companies, that is, 1 big and 1 small, perceived that their journeymen are competitive at work.

c) Respect for manual work:
Analysis of schemes of work used in both the colleges showed detailed practical processes that trainees have to go through. In addition to the various machines that trainees work on, they also do intensive bench fitting. Most of

the students perceived that manual work is as good as other types of work or that it is better than other types of work (see Table 1).

Table 1. Students' perceptions about manual work in both the colleges.

VARIABLE	PRE-IND. COLLEGE N	PRE-IND. COLLEGE %	POST-IND. COLLEGE N	POST-IND. COLLEGE %
manual work is better than other types of work	10	26.3	15	31.9
manual work is as good as other types of work	23	60.5	20	42.6
manual work is not as good as other types of work	5	13.2	12	25.5

Five companies, that is all 3 big companies, 1 medium and 1 small company, expressed views that their journeymen do have respect for manual work. The other 4 companies' responses showed that some of their journeymen have no respect for manual work.

d) Pride in workmanship:
All the 85 students in both the colleges indicated that they take pride in their own workmanship. The lecturers asserted that this is an important attitude which they foster in students. Employers' perception was different. Six companies complained that most of the journeymen in these companies do not take pride in their own workmanship. Only 2 big companies and 1 small company expressed views that their journeymen are proud of their workmanship.

e) Cooperation:
Cooperation among students and between lecturers and students was generally considered very important in both the colleges. Only 8 (9.4%) out of the 85 students in both the colleges indicated that cooperation is not encouraged.

On the same issue 6 companies argued that their journeymen are very cooperative. These comprised all the 3 big companies, 1 medium and 2 small companies. Only 2 medium companies and 1 small company criticised some of their journeymen for not being cooperative.

f) Reliability:
Although this attitude was considered to be important in both the colleges, only 4 companies expressed satisfaction about the reliability of their journeymen. These comprised 2 big and two small companies. All the 3

medium companies, 1 big and 1 small company complained that some of their journeymen are not reliable.

g) Summary:
There is a fair correspondence between what colleges provide and the requirements of industry concerning punctuality. On the whole, the level of competitiveness fostered in students, does not match employers' expectations. Respect for manual work is adequately fostered in students by colleges. Pride in workmanship is not fostered in students to the level required in industry. There is generally a correspondence between the degree of cooperation fostered in students and the requirements of industry. In the eyes of employers, colleges foster reliability in students fairly well.

3.3.5 Adaptability and other abilities

a) Preparing trainees for inevitable changes in industry:
The responses from both the colleges indicated that trainees are adequately prepared for technological changes in industry. At the pre-independence college the interviewees claimed that adaptability is fostered through providing students with engineering journals about developments in industry; organising educational visits to different industries and attaching students wherever possible to companies with modern and diversified equipment. Documents revealed that trainees are exposed to theoretical knowledge about modern materials such as plastic. However, a close scrutiny of the syllabus and schemes of work revealed a tendency to focus on traditional skills training. At the post-independence college interviewees proclaimed that adaptability is fostered in trainees through: organising visits at least three per year to companies with some up-to-date equipment; showing trainees current engineering journals with different types of machines design. Documentary information revealed that students are taught the theory of some of the latest developments in engineering industry for example plastic and CNC machines. But again, as in the pre-independence college, the schemes of work in skills training tended to focus on traditional approach. There was no indication of looking into the future.

On the same issue, 5 companies gave responses which indicated that their journeymen are sufficiently prepared for changes in industry. These comprised 2 big, 2 medium and 1 small company. One of these big companies contended that the established link between the company and technical colleges helped to ascertain that trainees are equipped with the necessary versatility. The other big company attributed the adaptability of its journeymen to the existing dual system of training. The small company argued that trainees come from college with new ideas that help to develop the company's production. On the other hand, 4 companies asserted that students are not trained to be adaptable to change. These compris[illegible] 1 big, 1 medium

and 2 small companies. The big company argued that training programs do not cope with production changes in industry. The medium company argued that journeymen are not sufficiently versatile and flexible. The small companies asserted that trainees are not prepared for any changes because technology in Zimbabwe is static.

b) Ability to solve problems:
In both the technical colleges, problem solving is taken up in materials science / engineering science, applied mathematics and drawing. Schemes of work in skills training however, showed that copying and repeating was the prevalent norm.

Three companies, that is 2 big and 1 medium, expressed views that it is not the role of a journeymen to solve problems. The supervisor, foreman or workshop manager does this. Two companies, that is, 1 medium and 1 small, considered journeymen's ability to solve problems as good. Three companies, 1 big and 2 small, argued that journeymen can only solve basic problems. Otherwise in other cases they need a lot of guidance. The third medium company perceived journeymen's ability to solve problems as satisfactory.

c) Ability to make decisions:
Whereas decision making seemed to be encouraged in both the technical colleges, 5 companies disclosed that ability to make decisions is not required. These companies stated that either the supervisor or the foreman makes production decisions. Three companies asserted that decision making is important but they did not perceive that journeymen could function without guidance. One small company saw its journeymen as being good at making decisions.

d) Ability to concentrate at work:
Both the colleges viewed students' ability to concentrate at work as adequate. It was asserted that this ability is encouraged in the day-to-day learning activities.

Two companies perceived journeymen's ability to concentrate at work as very good, 4 companies as good. One of these 4 companies a small one, contended that it is only the experienced journeymen who are good. Recently qualified journeymen are poor. The other 3 companies saw journeymen's ability to concentrate at work as satisfactory.

e) Ability to exercise initiative:
Although interviewees in both the colleges claimed that students are encouraged to exercise initiative, there was no documentary evidence to support this. However, students supported this claim. Only 19 (22.4%) out of the 85 students indicated that they are not encouraged to exercise initiative.

Five companies asserted that journeymen's ability to exercise initiative is fair. One of these stated that the initiative is, however, sometimes wrongly directed. One medium company perceived that journeymen's ability to exercise initiative is satisfactory. One big company perceived this ability as inadequate. One small company saw the ability as good. Only 1 big company pointed out that it does not require its journeymen to exercise initiative.

f) Ability to innovate:
In both the colleges documentary evidence showed that there are no opportunities for students to create and invent. Design is reflected in the syllabus, under drawing and design, but schemes of work did not show its execution.

None of the 9 companies expected journeymen to be innovative. The general contention was that production systems in the country do not encourage invention.

g) Summary:
There is no coherence of perception concerning journeymen's adaptability to changes in industry. On one hand, both the colleges and 5 companies felt that journeymen were adequately prepared for changes in industry. On the other hand, 4 companies asserted that they are not. There are mixed perceptions concerning journeymen's ability to solve problems. Three companies saw this ability as adequate. Three saw it as inadequate. The remaining 3 companies contended that journeymen are not expected to solve production problems. There are also mixed perceptions about journeymen's ability to make decisions. Five companies did not require journeymen to make production decisions. Three companies asserted that decision making is important but unfortunately journeymen cannot function without guidance. Only 1 company saw its journeymen as being good at making useful decisions. On the whole, journeymen's ability to concentrate at work matches employers' expectations. There is generally a fair match between the ability to exercise initiative fostered in students, and the requirements of industry. None of the 9 companies expected journeymen to be innovative and colleges did not create opportunities for students to invent.

3.4 Compatibility in terms of plant and equipment

To determine if plant and equipment used in technical colleges are compatible with industry requirements/set ups, the information obtained through inventories and interviews, was analysed. The first issue was to establish whether information obtained through interviews reflected compatibility or incompatibility of equipment used in technical colleges with the requirements of industry.

The general feeling in the pre-independence college was that equipment available in the college is basically compatible with that found in industry. It was asserted that, although some machines in the college could be smaller than those in industry, the functioning principles are the same. Furthermore, it was pointed out at this college that where there is a shortfall, students are taken to industry to alleviate the problem. It was also mentioned at this college that maintenance and repair is a major problem due to inavailability of spare parts in the country.

The post-independence college asserted that equipment in the machine shop is compatible with that in industry. This college stated that in terms of quality, heavy machinery could even be a step ahead. However, it was pointed out that the machine shop lacks some specialised machinery found in industry. Computerised Numerical Control (CNC) machines were mentioned as an example.

Eight companies thought that equipment used in technical colleges is basically compatible with what exists in industry and that the equipment is very suitable for training purposes. Only 1 small company perceived the compatibility of equipment used in technical colleges with that found in this company as relative. The reason given was that this company utilises specialised equipment such as pneumatic presses, and this equipment is not available in technical colleges. Among the 8 companies, one big company, 2 medium companies and 2 small companies, pointed out that some equipment in technical colleges is even superior in quality to that found in some companies. As a matter of fact, there was a general complaint in industry that their equipment is old and that they cannot get foreign currency to replace. It was asserted by these companies that technical colleges are in a better position than industry to acquire new machines. However, 4 companies, comprising 2 big companies and 2 medium companies, said that technical colleges should have CNC machines.

Analysis of information also indicated that plant size and configuration simulate real work conditions in industry fairly well. However, it was unanimously spelt out by both the colleges and all the nine companies that plant size and configuration in technical colleges are not expected to simulate real production set ups in industry. The argument featuring was that colleges have a training set up and industry has a production set up.

The pre-independence college pointed out that space in the plant is inadequate. In the post-independence college the feeling was that it is very adequate.

The condition of equipment was recorded in the inventories. The heavy machinery and precision instruments were judged in terms of their condition being good, satisfactory or poor, and if they were new, fairly new or old. A computer Stat View 512+tm program was used to establish the typical condi-

tion of equipment in each of the colleges, and in each group of the companies-big size, medium and small size. The outcome of the analysis indicated that precision instruments in both the colleges, and in all the nine companies are in good working condition and fairly new. The heavy machinery in the pre-independence college and in each of the 9 companies varied in condition and age. It is only in the post-independence college where all the heavy machinery is new and in good working condition. Figures 8 to 11 show the outcome of the analysis concerning the condition and age of heavy machinery existing in the pre-independence college, and in each group of the nine companies.

Figure 8 shows that half of the heavy machinery (50%) in the pre-independence college is in good working condition and is fairly new. (42.9%) of the heavy machinery is in good working condition, although it is old. The figure also shows that there are no new machines in the pre-independence college.

Figure 8. The condition and age of heavy machinery in the pre-independence college.

In figure 9 it can be seen that the typical condition of heavy machinery in the big companies is that it is in good working condition but old (50%). Very little machinery is good and new (8.3%).

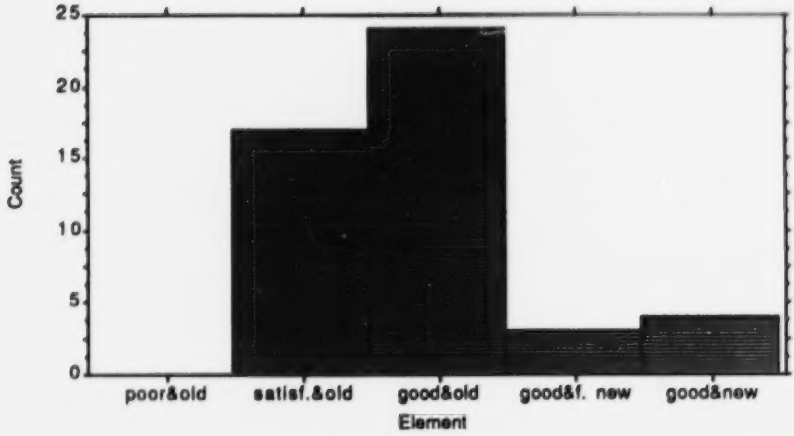

Figure 9. The condition and age of heavy machinery in the big companies.

Figure 10 shows that in the medium companies, most of the heavy machinery is in good condition, but old (63%). Very little machinery is in poor condition (3.7%). It can also be seen that there are hardly any new machines (7.4%).

Figure 10. The condition and age of heavy machinery in the medium companies.

Figure 11 shows that most of the heavy machinery in the small companies is in good working condition, though old (47.8%). This is followed by the

heavy machinery which is in satisfactory working condition, but old (39.1%). New machines are almost non-existent (8.7%).

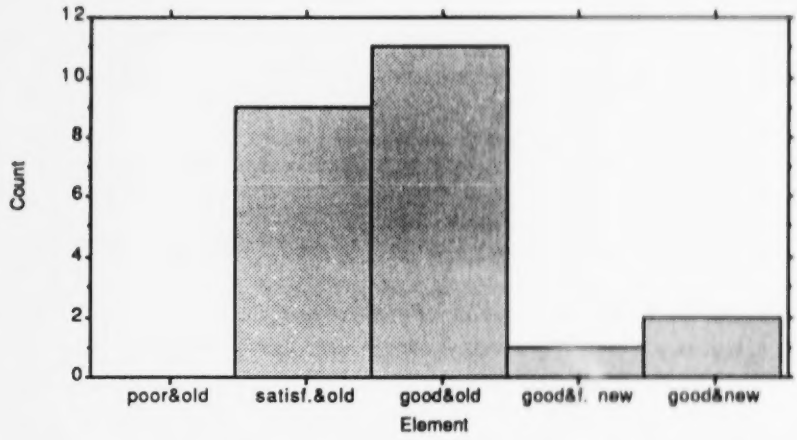

Figure 11. The condition and age of heavy machinery in the small companies.

It is apparent that the working condition of heavy machinery in both the colleges basically corresponds well with the working condition of heavy machinery in all the three groups of companies, in the sense that in all the companies and the colleges, the condition of heavy machinery is satisfactory or good. It is only in the medium companies that some of the heavy machinery is in poor condition, but very little (3.7%).

Analysis of information obtained through the inventories also showed whether types of heavy machinery and precision instruments found in each of the colleges are found in each of the nine companies. Almost all types of precision instruments found in each of the colleges, were found in each of the companies. But the position was different for heavy machinery. Table 2 illustrates that some heavy machinery in some of the nine companies does not necessarily exist in the colleges. The table also shows that some machinery in one company does not necessarily exist in the other companies.

Table 2. Type of heavy machinery in the companies' and in the colleges' machine shops.(notes, x: machine existing and -: machine not existing)

Heavy machinery	Big cos.			Medium cos.			Small cos.			Pre-ind. college.	Post-ind. college.
	A	B	C	D	E	F	G	H	J		
Centre lathe	x	x	x	x	x	x	x	x	x	x	x
Milling machine	x	x	x	x	x	x	x	x	x	x	x
Drilling machine	x	x	x	x	x	x	x	x	x	x	x
Radial drill. m/c.	x	x	x	x	-	x	x	x	-	x	x
Surface grinder	x	x	x	-	-	x	x	x	-	x	x
Shaper	x	x	x	-	-	x	x	x	-	x	x
Bandsaw	x	x	x	x	x	-	-	x	x	x	-
Horizontal borer	x	x	x	x	x	x	x	-	-	x	-
Tool&cutter grind.	x	x	x	-	x	-	-	x	-	x	x
Cylindrical grind.	x	x	x	-	x	-	-	x	-	x	x
Threading m/c	x	x	-	x	-	-	-	-	-	x	x
Turret lathe	x	x	x	-	-	x	-	-	-	x	-
Planer	x	x	x	x	-	-	-	-	-	-	-
Press	x	-	-	-	-	-	-	x	x	x	-
CNC lathe	-	x	x	-	x	x	-	-	-	-	-
Sloter	x	x	x	-	-	-	-	-	-	-	-
Vertical borer	x	x	x	-	-	-	-	-	-	-	-
Key seater	x	-	-	-	x	-	-	-	-	-	-
Lapping machine	-	x	x	-	-	-	-	-	-	-	-
CNC milling m/c	-	x	-	-	-	-	-	-	-	-	-
Multi drilling m/c	-	-	-	x	-	-	-	-	-	-	-
Pneumatic press	-	-	-	-	-	-	-	-	x	-	-

4. DISCUSSION

The research area of this study concerns the relevance of technical/vocational education programs in preparing students for the world of work. The purpose of the study was to examine the relevance of existing machine shop engineering programs in technical colleges, in preparing students for the world of industry in Zimbabwe. The following research question was asked: 'What is the relationship between existing machine shop engineering programs in technical colleges and the requirements of industry in Zimbabwe?'

4.1 Summary and conclusions

The analysis in this study concentrates on the relationship between machine shop engineering programs in technical colleges and the requirements of industry in Zimbabwe. Major findings can be summarised as follows:

a) Information relating to the nature of communication between colleges and industry, showed that there does exist contact between technical colleges and industry. Only 1 small company out of the 9, asserted that it has no contact.

Three principal modes of contact were identified. These include: reciprocal contact, one way contact: either from college to industry, or from industry to college. Six companies have regular contacts with technical colleges and 2 have irregular contacts with technical colleges. These 8 companies provide on- the-job training for students.

b) The analysis showed the existence of consultation on curriculum development between colleges and companies, with 4 companies acknowledging this consultation and 5 companies asserting that they are not consulted at all. Direct consultations are through advisory council/liaison committee meetings. Indirect consultations are through National Manpower Advisory Council (NAMACO) and through FEEB. Major consultation takes place once per year through NAMACO. Consultation between FEEB and employers' associations was non-existent at the time of the study. Two big companies asserted that their expertise is sought by technical colleges throughout crucial stages of curriculum development and whenever curricula changes are to be made.

c) When it concerns curriculum/syllabi, resources and schemes of work, it was found that 8 companies saw the length of training for machine shop engineering as adequate, and that students also have on-the-job training. On the other hand, lecturer/student ratio, depth and breadth of lecturers' industrial experience and expertise, and consumables in colleges were seen by most

of the companies as inadequate. Most of the lecturers in both the colleges lack formal teacher training qualifications, and there were no exchange programs in operation where lecturers from colleges work in industry for a certain period and specialists from industry are seconded to colleges for a similar period. The pre-independence college and 5 companies perceived quantities of equipment in technical colleges as inadequate, but the post-independence college and 4 companies saw it as adequate.

d) The companies, on the whole, perceived the following aspects of knowledge fostered in students by technical colleges as adequate: industrial safety, up-to-date resources in industry, materials science /engineering science, mathematics and interpretation of assembly drawing. Technical colleges do not foster in students knowledge about trade unions / labour organisations or knowledge about workshop management and organisation. None of the companies said that they require journeymen to display expertise in workshop management and organisation. It was pointed out by both the colleges that there was an acute shortage of textbooks- especially of materials science/ engineering science and applied mathematics.

e) Five companies out of the 9 saw journeymen's level of practical skills as adequate and the remaining 4 saw it as inadequate. Seven companies asserted that journeymen should be competent in reading drawings only, and not in drawing and design .

f) Concerning attitudes fostered in students by technical colleges, most of the companies saw the following as adequately fostered in students: punctuality, respect for manual work, cooperation and reliability. However, 6 companies complained that journeymen are not competitive and that they do not take pride in their own workmanship.

g) Five companies said that journeymen are adequately prepared for changes in industry, and the remaining 4 asserted that they are not adequately prepared.

None of the nine companies expected journeymen to be innovative and neither college created opportunities for students to be inventive. Three companies did not require journeymen to solve production problems and 5 did not require them to make production decisions. Three companies saw journeymen's ability to solve problems as adequate and 3 saw it as inadequate. Three companies asserted that decision making is important, but they did not perceive that journeymen could function without guidance.

h) Interviews indicated that equipment used in technical colleges is basically compatible with equipment found in industry. Only 1 company perceived this compatibility as relative.

Inventories indicated that precision instruments in both the colleges and in all the nine companies are in good working condition and fairly new. The working condition of heavy machinery in both the colleges basically corresponds with the working condition of heavy machinery in all the companies. However, most of the heavy machinery in the companies is old but in good working condition. Most of the heavy machinery in the pre-independence college is in good working condition and is either old or new. All the heavy machinery in the post-independence college is new and in good working condition. All types of precision instruments found in the two colleges were found in every company too. However, some heavy machinery found in some of the nine companies does not exist in the colleges and some heavy machinery in one company does not necessarily exist in the other companies due either to the specific products made in a particular company, or to lack of foreign currency to purchase the type of heavy machinery.

Based particularly on the 9 companies interviewed, the following conclusions could be drawn: Communication exists between technical colleges and industry, but only with the companies that provide on-the-job training for students. Contacts seem to be more regular than irregular. Consultation on curriculum development exists between CRDU and industry but it appears consultation tends to involve big companies, while neglecting the medium and small companies. With the big companies consultation is regular and timely.

FEEB was not sufficiently active on curricula issues. The training duration and on-the-job training for students correspond to the requirements of industry. However, lecturers' experience and expertise, lecturer/student ratio, exchange programs and supplies of consumables in colleges are seen by industry as inadequate, though important. There is no coherent perception about adequacy of equipment in colleges. Knowledge fostered in students, on the whole, corresponds to the requirements of industry. What is lacking is knowledge about trade unions/labour organisations. The level of journeymen's practical skills corresponds fairly well to the requirements of industry. On the whole, there is compatibility between attitudes fostered in students in technical colleges and the requirements of industry, save for competitiveness and pride in workmanship. There is no coherence in perception concerning journeymen's adaptability to changes in industry. Except for the ability to concentrate at work, none of the other abilities, for example, innovativeness are required in industry. Journeymen are not expected to have knowledge about workshop management and organisation. Equipment in technical colleges is basically compatible with industry requirements/set ups although some heavy machinery- for example CNC machines- are lacking in some colleges.

The investigation effectively showed the nature of communication, and consultation on curriculum development between technical colleges and industry. A comprehensive relationship was identified between knowledge, skills,

attitudes and adaptability provided by technical colleges and the requirements of industry. The investigation also successfully determined the compatibility between equipment used in technical colleges and the equipment found in industry. It showed that most of the heavy machinery in industry is old, although it is generally in good working condition.

4.2 Interpretation of the results

The working definition of relevance in this study was compatibility between machine shop engineering programs in technical colleges and the requirements of industry in Zimbabwe.

The results have shown that there are no exchange programs where lecturers spend some time on secondment in industry and specialists from industry spent time in technical colleges. According to the literature review, exchange programs are very important in promoting compatibility between what students learn in colleges and the requirements of industry (see e.g. Wray, 1982; Manpower Services Commission, 1985). Lecturers need frequent industrial experience in order to keep themselves abreast of developments in industry. This will ensure that the skills and knowledge imparted to students are compatible with what they will encounter in the real world of work. This approach, if implemented in Zimbabwe, besides improving links between technical colleges and industry, will enhance and consolidate lecturers' experience and expertise in machine shop engineering which is currently perceived by industrialists as inadequate.

There is a shortage of important resources in technical colleges, for example, relevant textbooks and consumables for use in machine shop engineering, yet these are important to ensure that relevant qualities to the world of work are fostered in students. It is one thing for technical colleges to feed industry with a number of qualified journeymen every year, and it is another thing to turn students into quality manpower to match the demands of industry and the demands of the future. Machine shop engineering is basically a practical subject. One cannot see how students will be able to master the subject without the necessary diversity of consumables for them to use. The heavy machinery in college workshops will not mean much to a student if it is not complemented by adequate supplies of necessary engineering materials.

The findings reflected that FEEB was not sufficiently active at the time of the study. However, in the literature review, great importance is attached to examination boards in that they help to ensure curricula relevance. It was contended in the literature that colleges and industry should be well represented on examination boards (see e.g. Visalberghi, 1973; Deutscher Industrie-und Handelstag, 1987) but at the time of this study no FEEB-colleges-industry meetings were held. The foundation of this study also places

emphasis on curriculum relevance in technical colleges, in order to foster in students the kind of skills, knowledge, attitudes and adaptability required in industry. If there is no regular correspondence between FEEB, colleges and industry, students may go through examinations which have little bearing on what they will encounter in industry as qualified journeymen. To ensure a more rigorous participation in curricula issues in machine shop engineering, the number of staff at FEEB should perhaps be increased.

Consultation on curriculum development exists between the Curriculum and Research Development Unit for technical colleges on the one hand and industry on the other. However, this consultation seems to involve big companies, neglecting the medium and small companies. The consultation with big companies seems to be regular and timely. According to the literature review, consultation on curriculum development is important because it ensures that institutional programs keep pace with technological developments in industry (see e.g. Tanner, 1975; Banchik et al, 1979). In the foundation of this study, it is also explained that regular consultation on curriculum development between college and industry ensures that the student gets the skills, knowledge, attitudes and adaptability which are compatible with the requirements of industry. In the light of this foundation, relevance of curriculum used in technical colleges in Zimbabwe, could be enhanced if all categories of the engineering industry were adequately represented when curriculum development was discussed. There could also be a need to increase the number of staff at CRDU, to enable a total involvement in both field work- visiting/ consulting colleges and all levels of industry, and office work- developing curricula and organising seminars and workshops.

On the whole, the level of practical skills acquired by students corresponds fairly well to the requirements of industry. The compatibility between equipment used in technical colleges and equipment found in industry contributes to this. The planned work experience for students contributes to this end too. The literature review highlights the necessity of compatibility between equipment in colleges and in industry, so that skills are easily transferred from colleges to related occupations in industry. It is also argued in the literature that skills acquired by students become even more relevant if students are provided with planned work experience in industry (see e.g. Manpower Services Commission, 1985; Deutscher Industrie-und Handelstag, 1987).

The planned work experience enhances the quality of students' practical proficiency. In industry there should be provision of up-to-date resources, real work conditions and subject specialities. However, the level of journeymen's practical skills is not as high as it should be, probably due to inadequate machine/students ratio in some colleges. Planned work experience does not guarantee quality training because some companies to which students are attached, lack a full complement of machine shop facilities, and that

instructors (qualified journeymen) in some companies may not necessarily be experts. Probably a student should be attached to different companies during his planned work experience, in order to give him the necessary diversity and depth of machine shop engineering experiences. Alternatively, all companies that provide planned work experience should be adequately equipped and have expert instructors.

Based on the 9 companies interviewed, the results show that some companies do not expect journeymen to solve production problems. The results also show that, on the whole, the companies do not expect journeymen to have knowledge about workshop management and organisation, to have drawing and design skills, to make production decisions, or to be innovative. Noteworthy is that workshop management and organisation, and the ability to innovate are not provided for in colleges nor are they required by the companies. Yet, experiences elsewhere show that knowledge of workshop management and organisation helps the working personnel in industry to communicate effectively with management, and to be involved in the planning and evaluation of production activities (Inoue, 1985), which could also be desirable in Zimbabwean situation.

Colleges involve students in decision making, problem solving, and drawing and design to a varying extent, although journeymen are not expected to apply these in industry. The literature review certainly supports this teaching. A relevant curriculum should foster in students a problem solving mentality, by active participation in one's task, rather than unthinking formal obedience and avoidance of direct responsibility (see e.g. Fägerlind and Saha, 1983; Doherty, 1985; Yoloye, 1986).

Involving journeymen in the planning and evaluation of production problems, could generate new and diversified ideas and solutions that would in the long run help the country to solve its technological problems. That the nine companies used in this study did not expect journeymen to be innovative, should certainly not imply that drawing and design be cut out of the curriculum. The students need these skills and knowledge in order to effectively prepare themselves for the future engineering industry of Zimbabwe. The industry may change from the present copying and making to designing and making instead.

The findings of this study could be of immense use to CRDU and FEEB in their continued efforts to design and develop curricula for use in technical colleges. The findings could strengthen the relationship between technical colleges and industry, and this would ensure even more relevant training. Policy makers could also exploit the findings of the study in their regular reviews and evaluations of technical education programs in Zimbabwe.

Some factors, for example, lack of adequate resources in technical colleges, non-existence of exchange programs of staff between technical colleges and industry, and the fact that some companies either lack up-to-date heavy machinery or a full complement of machine shop engineering facilities, seem to affect the quality of manpower produced to work in industry. For this reason there would seem to be a strong case for further research into machine shop engineering programs in technical colleges, in Zimbabwe. A study could be carried out to look into the possibility of introducing a working system for the exchange of staff between technical colleges and industry. A tracer study is recommended to examine the effectiveness and efficiency of on-the-job training/planned work experience. The causes of shortages of consumables in technical colleges will be an important problem to determine. Finally, there is also a strong case for an investigation into how some of the heavy machinery in the engineering industry could be up-dated considering present economic circumstances in Zimbabwe.

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Appendix 1

INTERVIEW SCHEDULE FOR PRINCIPALS OF THE TECHNICAL COLLEGES

NAME OF TECHNICAL COLLEGE _____

DATE _____

1. NATURE OF COMMUNICATION

1.1 Is there any contact between your college and industry?

_____

_____

_____

1.2 (If answer is yes): In what ways does the contact take place?

_____

_____

_____

1.3 How frequent is the contact?

_____

_____

_____

_____

1.4 Who is involved in this contact?

_____

_____

_____

2. CURRICULUM/SYLLABI

2.1 What is the duration for machine shop engineering programs?

_____

_____

2.2 Is the time sufficient to fullfil the goals of the program?

2.3 What is the existing lecturer/student ratio?

2.4 Do the programs in machine shop engineering include planned work experience in industry?

2.5 Is there provision of exchange programs where machine shop engineering lecturers spend some time on secondment to local industry and the industrialists are seconded to college for a similar period?

Appendix 2

INTERVIEW SCHEDULE FOR HEADS OF DEPARTMENTS IN TECHNICAL COLLEGES

NAME OF TECHNICAL COLLEGE _____

DATE _____

1. NATURE OF COMMUNICATION

1.1 Is there any contact between your department and industry ?

_____

_____

1.2 (If answer is yes): In what ways does the contact take place ?

_____

_____

_____

1.3 How frequent is the contact ?

_____

_____

_____

_____

1.4 Who is involved in this contact ?

_____

_____

_____

_____

2 CURRICULUM/SYLLABI

2.1 Is the program duration sufficient to fulfill its goals ?

2.2 Is the equipment enough to cater for the number of students ?

2.3 Are there adequate supplies of consumables ?

2.4 Are appropriate textbooks for the program available ?

2.5 Do the programs in machine shop engineering include planned work experience in industry ?

2.6 Do lecturers in your department have industrial experience ?

2.7 Is there provision of exchange programs where lecturers in your department spend some time on secondment to industry and the industrialists are seconded to your department for a similiar period ?

3 KNOWLEDGE

Estimate the time spent on each of the following :

.Trade unions / labour organisations _____

.Industrial safety _____

.Workshop management and organisation _____

.Up to date resources in industry :

_equipment _____

_materials _____

_technology _____

.Material science/Engineering science _____

.Workshop calculations _____

.Drawing and design _____

4 SKILLS

4.1 What are your views concerning students' ability to interpret assembly drawings ?_____

_____

_____

5 ATTITUDES

5.1. Some of the qualities required by the world of work may not be shown in documents e.g. _ punctuality, competitiveness, _ _ _ .

(Handover the card to interviewee)

5.1.1 Which one/s do you consider to be the most important attitude/s to foster ?

5.1.2 How do you try to achieve this ? _____

_____

_____

_____

_____

6 ADAPTABILITY

6.1 How do you prepare students for technological changes in industry ?

_____

_____

_____

_____

7 OTHER ABILITIES

7.1 Estimate time spent on Problem solving ?

_____

7.1.1 How is it fostered in students ? _____

_____

_____

7.2 Are students encouraged to make decisions in the learning process ? If so how is this achieved ? _____

_____

_____

_____

7.3 Do students show adequate ability to concentrate in their work ?

_____

_____

7.4 Are students encouraged to exercise initiative ?

_____

_____

7.5 Does the course equip students with innovative capabilities ? If it does, how is this achieved ? _____

_____

_____

8 PLANT AND EQUIPMENT

8.1 What are your views about the compatibility between the type and condition of machine shop engineering equipment in your department and what is found in industry ?

8.2 Do the size and configuration of workshops in your department simulate real work conditions and organisation in industry ?

Appendix 3

INTERVIEW SCHEDULE FOR PERSONNEL MANAGERS IN INDUSTRY

NAME OF COMPANY_____ SIZE OF COMPANY_____

DATE _____

1 NATURE OF COMMUNICATION

1.1 Is there any contact between industry and technical colleges ?

_____

_____

(If answer concerns consultation, continue with questions 2.2)

1.2 (If answer is yes) : In what ways does the contact take place ?

_____

_____

_____

1.3 How frequent is the contact ? _____

_____

_____

2 NATURE OF CONSULTATION ON CURRICULUM DEVELOPMENT

2.1 Is there any consultation between industry and technical colleges?

_____

_____

2.2 (If answer is yes) : In what ways does the consultation take place ?

_____

_____

_____

_____

2.3 How frequent is the consultation ? _____

_____

_____

_____

2.4 Who is involved in this consultation ? _____

_____

_____

2.5 When is your expertise required by colleges ? _____

_____

_____

3 CURRICULUM/SYLLABI

3.1 Do you think that students in technical colleges are given enough training period to acquire knowledge, skills and attitudes you expect from an employee at job entry level ? _____

_____

_____

_____

_____

_____

3.2 What is your opinion about the adequacy of resources in technical colleges in general, in trems of :

- lecturer/student ratio _____
- lecturer qualifications _____
- adequacy of equipment _____
- adequacy of consumables _____

3.3 Does your company provide on the job training opportunities for students from technical colleges ? _____

_____

_____

3.4 Are there exchange programs where lecturers from technical colleges work in industry for a certain period and specialists from industry are invited to work in colleges for a similiar period ?

4 KNOWLEDGE

4.1 Do the fitters and turners who trained in technical colleges show sufficient knowledge about the dynamics of trade unions/labour organisations?

Appendix 4

INTERVIEW SCHEDULE FOR WORKSHOP MANAGERS IN INDUSTRY

NAME OF COMPANY _____ SIZE OF COMPANY _____

DATE _____

1 NATURE OF COMMUNICATION

1.1 Is there any contact between industry and technical colleges ?

_____

_____

(If answer concerns consultation, continue with questions 2.2)

1.2 (If answer is yes) : In what ways does the contact take place ?

_____

_____

_____

1.3 How frequent is the contact ? _____

_____

_____

2 NATURE OF CONSULTATION

2.1 Is there any consultation between industry and technical colleges on curriculum development ? _____

_____

2.2 (If answer is yes) : In what ways does the consultation take place ?

_____

_____

_____

2.3 How frequent is the consultation ?

2.4 Who is involved in this consultation ?

2.5When is your expertise required by colleges?

3 CURRICULUM/SYLLABI

3.1 Do you think that students in technical colleges are given enough training period to acquire knowledge, skills and attitudes you expect from an employee at job entry level ?

3.2 What is your opinion about the adequacy of resources in technical colleges in general, in terms of :

- lecturer/student ratio
- lecturer qualification
- adequacy of equipment
- adequacy of consumables

3.3 Does your company provide on the job training opportunities for students from technical colleges ?

3.4 Are there exchange programs where lecturers from technical colleges work in industry for a certain period and specialists from industry are

invited to work in colleges for a similiar period ? _____

_____

_____

_____

4 KNOWLEDGE

4.1 Do the fitters and turners have enough knowledge about industrial safety at job entry level ? _____

_____

_____

_____

4.2 Do they know enough about workshop management and organisation ?

_____

_____

4.3 Are they adequately equipped with knowledge about up to date resources in industry e.g. equipment, materials and technology ?

_____

_____

_____

4.4 Do they know enough about materials science/engineering science?

_____

_____

_____

4.5 How would you rate the relevance of mathematical knowledge acquired by fitters and turners during their training in the technical colleges ?

_____

_____

4.6 How do you rate their ability in interpreting assembly drawings ?

_____

_____

5 SKILLS

5.1 Do your fitters and turners who received technical training in the technical colleges reflect the practical proficiency in fitting and machine work required ? _____

_____

_____

_____

_____

_____

_____

5.2 How do these fitters and turners fare in drawing and design ?

_____

_____

6 ATTITUDES

6.1 Do you think that machine shop engineering programs in technical colleges foster in students attitudes that correspond to industry requirements concerning the following :

- punctuality _____
- competitiveness at work _____
- respect for manual work _____
- pride in workmanship _____
- cooperation _____
- reliability _____

7 ADAPTABILITY

7.1 Do the machine shop engineering programs in technical colleges cope with inevitable technical or production changes in industry ?

_____

8 OTHER ABILITIES

8.1 How do you rate fitters and turners' ability to :

- solve problems _____
- make decision _____
- concentrate at work _____
- exercise initiative _____
- innovate _____

9 COMPATIBILITY OF PLANT AND EQUIPMENT

9.1 What are your views concerning the compatibility of machine shop engineering equipment used in technical colleges with equipment found in industry ? _____

9.2 Do you think that the workshop sizes and configuration in technical colleges adequately simulate the real situation in industry ?

Appendix 5

INTERVIEW SCHEDULE FOR CURRICULUM AND RESEARCH DEVELOPMENT UNIT (CRDU) AND FURTHER EDUCATION EXAMINATION BOARD (FEEB).

DATE _____

1. NATURE OF CONSULTATION ON CURRICULUM DEVELOPMENT

1.1 Is there any consultation between CRDU/FEEB and industry?

_____

_____

1.2 (If answer is yes): In what ways does the consultation take place?

_____

_____

_____

1.3 Should it be arranged differently?_____

_____

_____

_____

1.4 How frequent is the consultation?_____

_____

_____

_____

1.5 Is this enough? _____

_____

_____

_____

1.6 Who is involved in this consultation? _____

1.7 Who is involved from industry? _____

1.8 Should other people be involved? _____

1.9 What matters are discussed? _____

1.10 What should be discussed? _____

Appendix 6

INTERVIEW SCHEDULE FOR LECTURERS IN TECHNICAL COLLEGES

NAME OF TECHNICAL COLLEGE_____

DATE _____

1 CURRICULUM/SYLLABI

1.1 Is the program duration sufficient to fulfill its goals ?

_____

_____

1.2 Is the equipment enough to cater for the number of students ?

_____

_____

_____

1.3 Are there adequate supplies of consumables ?

_____

_____

1.4 Are appropriate textbooks for the program available ?

_____

_____

_____

1.5 Do the programs include planned work experience in industry ?

_____

_____

1.6 Does the existing lecturer/student ratio enable you to equip students with qualities that match with requirements of industry ?

_____

_____

1.7 Is there provision of exchange programs where lecturers spend some time on secondment to local industry and the industry subject specialists are seconded to teach your students at college for a similiar period ?

_____

_____

_____

2 KNOWLEDGE

Estimate the time spent on each of the following :

.Trade unions/labour organisations _____

.Industrial safety _____

.Workshop management and organisation _____

.Up to date resources in industry :

_equipment _____

_materials _____

_technology _____

.Materials science/Engineering science _____

.Work shop calculations _____

.Drawing and design _____

3 SKILLS

3.1 What are your experiences concerning students' ability to interpret assembly drawings ? _____

_____

_____

_____

_____

4 ATTITUDES

4.1 Some of the qualities required by the world of work may not be shown in documents e.g. _ punctuality, competitiveness _ _ _ .

(Hand over the card to interviewee)

4.1.1 Which one/s do you consider to be the most important attitude/s to foster ?

4.1.2 How do you try to achieve this ?

_____

_____

_____

_____

_____

5 ADAPTABILITY

5.1 How do you prepare students for technological changes in industry ?

_____

_____

_____

6 OTHER ABILITIES

6.1 Estimate time spent on Problem solving ?_____

_____

6.1.1 How is it fostered in students ? _____

_____

6.2 Do you encourage students to make decisions in their learning process?

If you do , how is this achieved ? _____

_____

_____

6.3 What is your experience about students' ability to concentrate in their work ? _____

_____

_____

6.4 Do you encourage students to exercise initiative ?

_____

_____

6.5 Does the program equip students with innovative capabilities ? If it does, how is this achieved ? _____

_____

_____

7 PLANT AND EQUIPMENT

7.1 What is your experience about the compatibility between the type and condition of college machine shop engineering equipment, and what is found in industry ? _____

_____

_____

_____

_____

_____

_____

7.2 Do the size and configuration of college workshops simulate real work conditions and organisation in industry ?_____

_____

_____

_____

_____

Appendix 7

ANALYSIS OF DOCUMENTS

NAME OF COLLEGE _____

DATE _____

1 CURRICULUM/SYLLABI

1.1 Provision of planned work experience

_____

_____

_____

_____

1.2 Provision of exchange programs

_____

_____

_____

_____

1.3 Timetable

_____

_____

_____

1.4 Adequecy of resources

_____

_____

_____

_____

_____

2 SCHEMES OF WORK/PLANNED ACTIVITIES

2.1 REFLECTION OF KNOWLEDGE ABOUT :

2.1.1 Trade unions/Labour organisations

2.1.2 Industrial safety

2.1.3 Real work conditions

2.1.4 Up to date resources in industry

2.1.5 Materials Science/Engineering Science

2.1.6 Workshop Calculations

2.1.7 Interpretation of assembly drawings

3 SKILLS

3.1 Type of skills and level of practical proficiency

3.2 Drawing and Design

4 REFLECTION OF THE FOLLOWING ATTITUDES

4.1 Punctuality

4.2 Competitiveness

4.3 Appreciation of efficiency in production

4.4 Respect for manual work

4.5 Cooperation

4.6 Reliability _____

_____

_____

5 REFLECTION OF POLYVALENCY - ADAPTABILITY

_____

_____

_____

_____

6 OTHER ABILITIES

6.1 REFLECTION OF THE FOLLOWING :

6.1.1 Problem solving _____

_____

_____

6.1.2 Decision making _____

_____

_____

6.1.3 Concentration faculty

_____

_____

6.1.4 Initiative _____

_____

_____

6.1.5 Innovativeness _____

_____

_____

Appendix B

QUESTIONNAIRE FOR MACHINE SHOP ENGINEERING STUDENTS IN TECHNICAL COLLEGES

I am an MA student in Metalwork - Education at Linköping University in Sweden. I am conducting a study on the relationship between technical education programs in technical colleges and the requirements of industry in Zimbabwe.

The purpose of this questionnaire is to get your experiences concerning machine shop engineering programs.

You do not have to write your name. The answers you give will be used only by the researcher in his study.

Please answer all questions and use a tick (/) to indicate your answer. There should be only one answer to every question.

The name of the college will not be mentioned in the report.

Thank you for your cooperation.

S. Gweru.

NAME OF TECHNICAL COLLEGE_____

DATE _____

.In what year of training are you ? _____

1 What are your views regarding time allocation for machine shop engineering program ? Give your reasons.

( ) too much time, because _____

( ) sufficient, because _____

( ) insufficient, because _____

2 What is your opinion about the lecturer/student ratio in the program ?

( ) very adequate

( ) adequate

( ) barely adequate

( ) inadequate

3 Do you at any time have visiting lecturers from industry to brief you on developments in industry ?

( ) yes

( ) no

4 Which of the following are included in the program :

( ) trade unions/labour organisations

( ) industrial safety

( ) workshop management and organisation

( ) up to date materials in industry

( ) up to date equipment in industry

( ) up to date technology in industry

( ) on the job training in industry

( ) materials science/engineering science

( ) workshop calculations

( ) drawing and design

( ) efficiency in production

5 Do you think that the program is equipping you with skilled workmanship that will enable you to cope with demands in industry ? Give reasons.

( ) yes, because _____

( ) no, because _____

6 Does the program give you opportunities to exercise initiative ?

( ) yes

( ) no

7 Is decision making encouraged in your learning activities ?

( ) yes

( ) no

8 Which approach among the following is prevailing in the program ?

( ) problem solving

( ) copy technology

( ) a combination of both problem solving and copy technology

9 How much emphasis is placed on punctuality in the program ?

( ) a lot

( ) not very much

( ) not at all

10 Are you encouraged to be competitive in your daily learning endeavour?

( ) yes

( ) no

11 Does the program encourage cooperation between lecturers and students?

( ) yes

( ) no

12 Does the program encourage cooperation among students ?

( ) yes

( ) no

13 How do you rate the quantity of equipment in machine shop engineering workshops ?

( ) very adequate

( ) adequate

( ) barely adequate

( ) inadequate

14 What is your opinion concerning the availability of materials in machine shop engineering ?

( ) very good

( ) good

( ) satisfactory

( ) poor

15 Is the availability of textbooks adequate ?

( ) yes

( ) no

16 How do you rate your knowledge about interpretation of assembly drawing ?

( ) very good

( ) good

( ) poor

( ) very poor

17 How do you rate your ability to concentrate at work ?

( ) very good

( ) good

( ) satisfactory

( ) poor

( ) very poor

18 What is your opinion about manual work ?

( ) Manual work is better than other types of work

( ) Manual work is as good as other types of work

( ) Manual work is not as good as other types of work

19 Do you take pride in your own workmanship ?

( ) yes

( ) no

Appendix 9

WORKSHOP EQUIPMENT INVENTORY / CHECKLIST

DATE _____

NAME OF COLLEGE / COMPANY _____

SIZE OF COMPANY _____

A. HEAVY MACHINERY

TYPE OF MACHINE	CONDITION

B. PRECISION INSTRUMENTS

TYPE OF INSTRUMENT	CONDITION

C. WORKSHOP CONFIGURATION